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Granulation Problems of New Zealand Honeys

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Introduction

New Zealand honey is being sold in the granulated form both on the local and the overseas market. Althought great care is taken in carrying out the granulation process, certain undesirable irregularities in the appearance of the honey frequently occur. One of the most serious of these is that known as "dry granulation" or "frosting," which reduces considerably the sales value of the honey. With a view to ascerta'ning the cause of dry granulation a series of investigations was commenced at the Cawthron Institute. While these investigations are not yet complete, many of the results already obtained are of great interest, and are presented here.

The Granulation of Honey

Ungranulated honey consists principally of an aqueous solution of glucose and fructose which is supersaturated with glucose. Sooner or later the glucose crystallises out, thereby producing granulated honey. If a large number of nuclei are provided artificially, crystallisation will proceed immediately, and this is the basis of the standard process employed in New Zealand for granulating honey. In this process a small amount of fine-grained granulated honey is added to the ungranulated honey at a temperature of about 25 degrees Centigrade. The fine-grained honey provides large numbers of small crystals of glucose to act as crystal nuclei. The honey is stirred till its temperature falls to about 15 degrees C., the stirring apparently serving to break up any large crystal aggregates and to ensure regular distribution of the nuclei. At a temperature of 15 degrees C., under these conditions granulation continues in a satisfactory manner. This procedure, which has been in commercial practice in New Zealand for many years, has been independently arrived at in Canada by Dyce.

The irregularity of granulation called "frosting" consists of light-coloured, dendritic markings in the granulated honey. This defect is frequently associated with the separation of the honey from the wall of the container and with fissures in the honey. Frosting may develop in an extensive manner from a small nucleus, giving an appearance of organic growth. It is not restricted in its development to the surface of the container, for it has been found deep in large bulks of honey in places where it is highly improbable that crystallised froth, possessing a somewhat similar appearance, would occur.

Physical Examination of Frosted Honey

The amount of honey showing pronounced frosting which was available was strictly limited, so chemical examinations had to be curtailed, but

small samples of light coloured frosted honeys and the corresponding darker normal honeys were examined by physical methods.

The only crystals found in any of the samples were those of glucose hydrate, but the mean diameter of the crystals in frosted honeys was less than in the corresponding normal honeys; further, the ratio of the colour of frosted honey to that of the corresponding normal honey was approximately the same as the corresponding ratio of the crystal diameters.

Factors Influencing "Frost" Formation

Observations made on typical honeys affected with frosting, and information obtained from honey packers, suggested that the occurrence of frosting is connected with the presence of air bubbles in honey. It is not considered that frosting is identical with the light-coloured froth found so often in honey, but rather that the air bubbles act as the nuclei around which frosting develops.

In order to investigate this aspect of frost formation, samples of honey with a high glucose content were placed in test-tubes (6in. by 1in.) and were then seeded with a fine-grained honey to induce germination. The conditions under which granulation was allowed to proceed were varied as follows:—

(a) Air was removed from four test-tubes with a vacuum pump.

(b) Air bubbles were introduced down the sides of four tubes.

(c) Air bubbles were introduced down the sides of four tubes, and in addition strips of filter-paper (one to each tube) were placed on the opposite side of the tube to the air bubbles. The object of the filter-paper was to provide additional supplies of air nuclei.

All the tubes were kept in the laboratory at room temperature during the granulation of the honey. The results of this experiment showed that in the absence of air no frosting occurred. Frosting was well developed in the case of treatments (b) and (c) from the areas where air bubbles or filter-paper had been introduced. The use of impervious wax seals or porous paper seals on the test-tubes did not appear to influence the results of the experiment.

Microscopic examination of an area of frosted honey round an air bubble showed the bubble to be no longer bounded by clean curves but by jagged crystals of glucose.

Volume Changes During Granulation

The presence of fissures in granulated honey and the separation of frosted honey from the walls of the container suggested the possibility that changes in honey volume occurred during granulation. Such a change in honey volume might well influence the occurrence of frosting. As no information was available concerning volume changes during the granulation process, the whole question was investigated.

Clear, ungranulated honey was seeded with 1 per cent. of a fine-grained "starter" honey and gently stirred for 30 minutes.

A weighed quantity of the honey was kept at 25 degrees C., for three months and the changes in volume which occurred were measured accurately and recorded. In these experiments four different honeys were used, namely, a viper's bugloss honey, a pohutukawa honey, a clover-catsear honey and a light honey from mixed floral sources. The volume of all these honeys contracted during granulation, the volume changes occurring in the clover-catsear honey being shown in the following table:

Time since granulation commenced in days	Contraction in volume per cent.
10	0.26
20	0.49
30	0.60
40	0.64
50	0.67
60	0.69
70	0.70
90	0.71

The clover-catsear honey, therefore, may be said to contract 0.71 per cent. in volume during granulation, for the table shows that at the end of 90 days contraction had practically ceased. In addition the rate of contraction can be shown to follow a definite mathematical law which is the same for all four honeys used.

Conclusions

(1) Frosted areas of honey contain glucose crystals of smaller diameter than those in the normal honey, and the colour of frosted and normal honeys is directly related to mean diameters of the crystals present.

(2) Frosting has been induced by the presence of air bubbles in honey, and in the absence of air-bubbles no frosting occurred.

(3) Contraction of volume occurs during granulation of honey.

These points suggest that frosting of honey is caused by the retreat of the liquid phase of honey from between the glucose crystals around air bubbles. Where such retreat had occurred, crystals would no longer grow in size during granulation, and the lighter appearance would be caused by the presence of air between the glucose crystals.

It is hoped that these observations into the nature of frosting will lead to a method for its control or prevention in commercial practice.

This article has been condensed by the author from his paper of the same title in the New Zealand Journal of Science and Technology for April, 1938.

Incorrect Statements

The "Scottish Beekeeper" of March contains the following: "Honey imported into the Irish Free State pays a duty of 1/- per pound, and New Zealand entirely prohibits the importation of honey, yet Britain takes in free practically the whole of the honey exported from New Zealand." This statement is quite incorrect, as New Zealand does not prohibit the importation of either Empire or foreign honeys.

"Beekeeping," an English journal, is quoted in the "Scottish Beekeeper" as follows: "The editor of "Beekeeping" believes that New Zealand's next move will be to solicit government aid to enable them to sell their honey in Britain at lower prices." Even without a subsidy (states the Scottish Beekeeper) New Zealand honey is sold in this country at less than it fetches in New Zealand. Here the British beekeeper might very fairly look to his government for "protection."—These statements are damaging and incorrect. The journals responsible should either prove their statements or withdraw them.

Building Good Combs

If good combs are to be obtained, they must be drawn above brood. The practice of inserting foundation between brood combs in the lower chamber, as a supposed swarm control method, is bad. Not only does it fail to prevent swarming, but it almost invariably results in inferior combs. In the event of a shortage of drawn combs in the application of the "Demaree" system, it is recommended that an empty super rim or hive body without frames be placed underneath the hive containing full sheets of foundation. The cluster will them be suspended from the bottom bars of the frames above, and will work upward gradually, thus avoiding the stretching of the foundation, and, if left a few days will usually draw most of the combs all the way down to the bottom bars. It is very important, to bear in mind, that this result can be expected only when there is sufficient nectar coming in.—E. S. Miller, in "Gleanings."

Many contributions and articles have unavoidably been held over till next issue.

Pollenization of Red Clover
By Honey Bees in New Zealand

Written by J. Foster, Washdyke, South Canterbury

Type of Country

In order to get reliable data on the pollenization of red clover in New Zealand, it is necessary that research work on this subject be undertaken.

The locality under discussion in this article can be identified on an ordinary school geological map of New Zealand. On the East Coast of the South Island, is an area of yellow with the word "Timaru" printed on it.

To the North along the coast is the river Opihi, which is the Northern boundary of the Levels County as far as its junction with the Tenawai when the Tenawai becomes the boundary. To the South is the Pareora River. The country extends generally in a North-Westerly direction from Timaru towards the foothills of the Southern Alps.

The yellow area referred to is the position of a great belt of dolerite rock country. The rock in places is covered with wind-borne soil to a depth of 30 to 40 feet.

To the North and North-East of this area, are the "Downlands" and the Southern end of the great Canterbury Plain. Honey bees work the red clover on the Downlands and the plain, the soil of the latter being alluvial (or water-borne).

The geological formation in the French and German classification is Trias Jura.

In the English classification it is three or four of the upper series of the New or Upper Red Sandstone, with the limestone formation overlying it.

Deficiency of Lime and Rainfall

The soil is deficient in lime for agricultural purposes, but this is being remedied by lime works which are established just across the river on the Northern boundary in the limestone formation.

The annual rainfall is about 24 inches. The officers of the Public Works Department took a measured quantity of the rainfall and placed it in an evaporation tank at Temuka which is just on the North of the Opihi River. Additional rainfall was prevented from securing ingress to the tank. When the measured quantity had evaporated, calculations showed that the area did not receive sufficient rainfall. As a result, one of the best irrigation schemes in the Dominion is now in active operation to supplement the rainfall.

Further, in about two years' time it is intended to provide a water supply for the Downlands with water troughs in almost every paddock for stock (and, of course, bees).

In seasons of partial drought or light summer rainfall from, say, Christmas onwards to early February, very little red clover seed is produced in the Levels County for the reason that the farmers want the growth for stock. The areas set apart for red clover seed are then just what can be spared—very small areas of eight to ten acres—to provide the farmer with seed for himself for his next spring and summer sowings.

Bumble Bees Inadequate

Under these restricted conditions it is quite possible that the bumble bees in the County were able to satisfactorily pollenize the red clover up to the season 1934-35.

The farmer never tries to secure his seed from his first crop of red clover, which is either fed to stock or made into hay by the middle of December, about the 10th of the month being the best date for cutting the hay. If a paddock has been grazed, the farmer runs the mower over it about December 15th and shuts it up for seed. These practices depend on rainfall.

After 1934-35 a different set of conditions came into operation. The bumble bees, which had become fewer in numbers since 1925, became

totally insufficient for pollenization purposes.

Suppose there is a rainfall of 2½ or 3 inches about Christmas time to New Year, another few inches in mid-January, a further 2 or 3 inches in early February, the whole face of the county is changed as if by magic. Grass is a foot high, and red clover perhaps higher still. Suppose, at the same time, that the price of clover seed is good, say 8d. to 1/- per lb. These two factors coming together, cause the farmers to increase the acreage set apart for seed infinitely beyond the pollenization capabilities of the bumble bees. In such a season orders for the use of colonies of honey bees come to me from farmers to help them cope with the problem of pollenization.

The farmer orders his bees in the same way as he orders his ammunition. He asks for "enough cartridges to shoot about 10,000 sparrows that are on his oats. Send them out with the cream lorry to-morrow." One of my first orders for bees was received during the first week in February several years ago. It read: "I have a paddock of 20 acres of red clover that I wish to keep for seed. Would you bring enough bees to put the seed into it. It is out in flower. I'll pay you well. There's not a bee on it."

Development of Technique

Then began a series of trial and error methods that lasted for five or six years to determine the correct number of honey bees necessary to fill orders. Finally I reached a mark that was fairly reliable. Research is needed to establish the correctness of my results.

At first I thought that, if I sent out one or two colonies of bees to a farmer, he would have a greater pollenizing force than if he had all the bumble bees in Canterbury. This did not follow. I could only see a few of my bees working the clover. I made a few more similar errors the first season—too few bees.

The next year I increased the force. An order for pollenizing 17 acres of red clover was received. I tried four colonies. Inspections of the field, and yield of seed, showed not enough bees.

The following year I tried ten 5-frame nuclei for 20 acres. These were unsuccessful.

The next season, for a 20-acre paddock of red clover, ten full one-storey colonies boiling over with bees were used. They were ready for a full depth super of combs to give the queen room to lay. This gave good results and the threshing returns from the area were over two bags of seed per acre, actually 45 bags to the 20 acres (a bag is 200lbs.).

During the next year I used 16 prepared full colonies of honey bees on 24 acres of red clover, and kept to that ratio for some years afterwards.

From my inspections of the bees at work I think the correct amount lies somewhere between:

One Hive to Two Acres
and
Two Hives to Three Acres.

For the last ten years I have worked between those amounts. I have, during numerous Februaries, watched the honey bees work on the second crop of red clover. I have had access at all times to the returns of the clover shellers, and have compared the concentration of bees per square yard during the pollenation period as against these yields.

When I see a concentration of **five or six bees to the square yard** of red clover bloom I am quite satisfied as to the probable result provided weather conditions are normal. I have frequently rung up a farmer on a very good working day for bees when they should be flying freely and got him to go to the red clover paddock and make a bee count per square yard.

It was stated by the Ohio State College that one colony of 7 or 8 standard frames of brood was sufficient to pollenize one acre of orchard, which is a slightly higher rate than that which I used for red clover.

To get bees to fill orders for pollenising purposes, I make about 50 to 75 three to five-frame nuclei (Lang-

-stroth hives) at end of November, which is supering-up time for the white clover honey flow. I gradually build these up to 8 or 9 frames of brood about the middle of January. If these nuclei are not full, 10-frame colonies by early February, they are strengthened with frames of brood from the colonies in the home apiary. All pollen combs are removed from these built-up nuclei, which are prepared with screens on tops and bottoms. The floor boards and covers are taken separately. The farmer does the trucking generally.

Locating the Apiaries

The bees are placed as near to water as possible, generally beside a dam, and as far away on the farm as possible from the red clover paddock —up to half a mile. In ordinary seasons bees work better by having a distance to fly. In wet seasons, right beside the paddock is the better position.

The pollinating apiary is visited within a week to discover the condition of the bees and to take a bee count on the red clover. If the count shows two or three to the square yard, the cause can generally be put down to other flowers blooming at the same time. In normal seasons the second crop of red clover has few rivals. The white clover flow may be just tapering off to a close. Catsear is another cause of trouble, and in some localities the Scotch thistle. These counter attractions seriously interfere with the pollination of the red clover. If upon investigation, it is found that the rival honey flow promises to continue, the only course is to bring more colonies of bees to restore the concentration on the red clover to 6 or 7 per square yard.

The yields of red clover seed vary from 1 bag to 3 bags (occasionally) per acre, the latter being sesured from small areas near to established apiaries. Most farmers are content with one bag per acre. An amount of seed is lost in the paddock if the blooming is early, and is not mature if the blooming is late.

Research Work Needed

The strains of bees I used were: 1913-14, Root's; 1916-17, Ruakura; 1918-20, Tauranga; 1926, Root's; 1932, Root's; 1934, Jay Smith's; last but not least, R. Stewart's.

I was unable to trace any working by the bees of the first crop of red clover flowers, or found any of the dark purple-brown pollen in the hives at this time.

On November 27, 1934, red clover pollen was brought into the hives of my home apiary and this continued until early January. This unusual occurrence was attributed to heavy applications of lime that had just previously become a general farm practice on farms surrounding the apiary. Investigation seemed to support this theory.

Fifty colonies of bees were within ¼-mile of land that was limed 4 or 5 years ago, and at the same time were within ½-mile of land that was heavily limed 2 years ago. The former paddock was well worked by the bees and set a good crop of seed, whilst the latter was neglected and produced no seed. The answer was, that bees travel short distances to work red clover in seasons of light but constant rainfall. The second paddock was too far away owing to the rainy weather. In a normal season the result would have been reversed.

I would urge that research work should be undertaken into these matters. For the last 20 years millions of honey bees have been working on the red clover blooms and pollinating them in the Levels Country—on the Downlands and on the soil of the dolerite belt. The results deserve recognition by further investigation.

LITERARY CONTRIBUTIONS for the N.Z. HONEYBEE must be posted to arrive at the address below by the 7th of each month, and copy of ADVERTISEMENTS to arrive by the 10th of each month.

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Honey Research

Chemical Investigations at the Cawthron Institute, 1937-38

The main lines of research into honey problems which are being pursued at the Cawthron Institute have been reported to previous meetings of the National Beekeepers' Association. These lines of research are connected with (1) the establishment of a process for the purification of honey of undesirable flavour and/or colour; (2) the pollens present in New Zealand honey; and (3) granulation or "frosting" problems. Work on all these problems has been continued during the year.

Purification Process

The laboratory work on the process suggested for the purification of low-grade honey was completed some time ago and has been already discussed at previous meetings. During the past year money has been made available, partly by subscriptions from beekeepers and partly by means of a Government grant, sufficient to purchase a small commercial-scale plant suitable for the testing of the process. This plant will treat about half a ton of honey per day and will enable experiments, hitherto restricted to a laboratory scale, to be continued on a semi-commercial scale. It is hoped that this plant will provide data to determine the economic prospects of the process. The plant, which had to be imported from the United States, has now arrived in Auckland. It is anticipated that the erection of the plant will commence during the present month.

Pollen Studies

Mention has been made in previous reports of the establishment of a collection of pollens likely to be associated with New Zealand honeys. During the past season this collection has been enlarged and is now becoming valuable for reference purposes in the identification of pollens present in honey. The collection contains specimens of both native and exotic pollens mounted by a standard procedure in filtered honey containing a preservative. The use of this medium for mounting not only preserves the pollen but facilitates comparison with commercial honey containing pollen.

The collection is proving increasingly useful both in identifying honey for research purposes and, on some occasions, assisting bee-keepers to locate sources of floral contamination. This collection should also prove useful should the source of a reputed New Zealand honey be questioned overseas, if the presence of pollen from New Zealand native plants be established then this would be certain evidence of origin.

Granulation or "Frosting" of Honey

During the past year considerable time has been given to a study of granulation problems, particularly in relation to "dry granulation" or "frosting." The initial work on this problem was reported last year, and experiments described then have been continued. A full report appears on another page.

In conclusion thanks are due to the Advisory Research Committee of the National Beekeepers' Association whose suggestions for research topics have been helpful and to those beekeepers who have provided honey for the experimental work.

The financial assistance of the Hon. Minister of Scientific and Industrial Research and of beekeepers in connection with the provision of special plant to test the Cawthron honey purification process is greatly appreciated.

The "Bee Kingdom"

A new venture has been inaugurated by the publishers of the "Bee Kingdom." Starting with the issue of last month the journal is to be published in separate editions—Arabic and English. The latter will comprise 40 pages with illustrations. The subscription is 6/- per annum.

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